Section II (Remarks)

The following discussion addresses the substance of the examiner's position in his October 25, 2005 Advisory Action.

The examiner at page 2 of the Advisory Action has asserted that "[I]t is well known that various technologist, scientist and engineers [sic] have developed gallium nitride substrates with the dimensions as disclosed in Applicants [sic] specification." The examiner thereupon has cited the following new references:

Maruska, H.P., et al., "Development of 50 mm diameter non-Polar Gallium Nitrate Substrates For Device Applications," IEEE International Conference on Indium Phosphide & Related Materials, May 16, 2003, pp 567-570 (hereafter "Maruska");

Vaudo et al., US Patent 6,596,079 (hereafter "Vaudo");

Tischler et al., US Patent Application Publication No. 20010055660 (hereafter "Tischler");

Dwilinski, et al. US Patent Application Publication No. 20020192507 (hereafter "Dwilinski"); and

D'Evelyn, et al. US Patent Application Publication No. 20020155634 (hereafter "D'Evelyn"), stating that "[T]hese are just a few examples that discloses [sic] what is well known in the art" (page three of the October 25, 2005 Advisory Action).

It is not apparent whether the examiner is in any way raising new grounds of rejection, or whether the foregoing references are simply being identified as background disclosures, in connection with the examiner's consideration of the term "large-area" as used in the applicant's claims.

Maruska fails to in any way disclose or suggest "Large-area, single-crystal semi-insulating gallium nitride," as required by applicant's broad claim 1.

Semi-insulators are characterized by bulk resistivity between 10^3 to 10^{10} ohm centimeters, but material of such character is not disclosed or suggested by Maruska.

Maruska describes the formation of thick films of gallium nitride, which as noted on page 569 of the article is described as having "a significant number of planar defects that we identify as stacking faults" and the conclusion of the article at page 70 is that "these wafers [of GaN] contain large densities of ABABACAC stacking faults." Apart from these disclosures of high densities of

defects, Maruska does not identify the GaN material as single crystal material, and Maruska does not identify the GaN material as semi-insulating. Further, Maruska contains no disclosure whatsoever of bulk resistivity. There is therefore no basis for attributing any resistivity or conductivity characteristics, or any single crystal character, to the Maruska material. The Maruska article contains no mention of "semi-insulative," "semi-insulating," or any similar terminology that would in any way indicate a material of the type claimed by applicants.

Vaudo and Tischler are commonly assigned references describing subject matter deriving from individuals including co-inventors in the present application.

Dwilinski contains no mention of "semi-insulative," "semi-insulating," or any similar terminology that would in any way indicate a material of the type claimed by applicants.

D'Evelyn contains a single mention of a semi-insulating active layer without further specification.

Thus, the additional references adduced by the examiner in the way alter the prior lack of basis for rejection of the applicants'claims.

At page 3 of the Advisory Action, the examiner has stated that

> **"Although Heitz does not provide the dimensions of the gallium nitride, the dimensions are trivial at best. It is not clear as to why Applicants believe a non-enforceable claim, as disclosed by claim 1, would have any value in a Patent."**

Applicants respectfully submit that it is not proper to reject a claim solely because of the type of language used to define the subject matter for which patent protection is sought. *In re Miller*, 441 F2d 689, 169 USPQ 597 (CCPA 1971). All that is required by 35 USC 112 is that the claims set out and circumscribe a particular area which the applicant regards as his invention with a reasonable degree of precision and particularity. *In re Moore*, 439 F2d 1232, 169 USPQ 236 (CCPA 1971).

Applicants therefore take issue with the foregoing characterization of the applicants' invention, and respectfully request reconsideration in light of these remarks.

In paragraph 7 at page 3 of the Advisory Action, the examiner has stated that "[W]here claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a prima facie case of either anticipation or obviousness has been established," that "[W]hen the PTO shows a sound basis for believing that the products of the applicant and the prior art are the same, the applicant has the burden of showing that they are not," and that "[B]ecause Heitz teaches a 'semi-insulative' material, the range of resistivity will inherently be limited to that of a material of being semi-insulative and not conductive."

In response, it is pointed out that applicants have clearly demarcated their claims over the disclosure of Heitz, and have pointed out that Heitz is devoid of disclosure or any suggestion whatsoever of the size of the crystal, and that there is no disclosure in Heitz et al. that identifies the GaN material of such reference as being single crystal in character.

The Examiner's position is premised on inherency of applicants' claimed invention. The law is not availing to the Examiner's position in this regard. Where a reference is alleged to inherently disclose a claim element, the missing element must necessarily be present in the cited reference and it must be so recognized by those of skill in the art. It is not enough that the missing element is possibly or probably present. *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999)(reversing a decision of the Board of Patent Appeals and Interferences that had affirmed the examiner's anticipation and obviousness rejections), *citing Continental Can Co. v. Monsanto Co.*, 948 F.2d 1264, 1268, 20 U.S.P.Q.2d 1746, 1749 (Fed. Cir. 1991). "Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient." *Continental Can Co.*, 948 F.2d at 1269, 20 U.S.P.Q.2d at 1749 (*quoting In re Oelrich*, 666 F.2d 578, 581, 212 U.S.P.Q. 323, 326 (C.C.P.A. 1981).

There is therefore no tenable ground for rejection of applicants' claims in the disclosure of Heitz.

The examiner correspondingly is requested to reconsider the following arguments concerning the patentable character of applicants' claimed invention.

The §102 and §103 Rejections of Claims 1-41, and Traversal Thereof

In the May 9, 2005 Office Action, the Examiner rejected claims 1-41 on reference grounds, including:

a rejection of Claims 1-10 under 35 U.S.C. §102(b) as being anticipated by **Heitz** et al., Excited States of Fe^{3+} in GaN, PHYSICAL REVIEW B., Vol. 55, No. 7, pp. 4382-4387 (Feb. 15, 1997) (hereinafter "Heitz");

a rejection of Claims 11-38 under 35 U.S.C. §103(a) as being obvious over **Heitz**;

a rejection of Claim 30 under 35 U.S.C. §103(a) as being obvious over **Heitz** in view of **Heikman** et al. Growth of Fe Doped Semi-Insulating GaN by Metalorganic Chemical Vapor Deposition, APPLIED PHYSICS LETTERS, Vol. 81, No. 3, pp. 439-441 (July 15, 2002) (hereinafter "Heikman"); and

a rejection of Claims 14 and 39-41 under 35 U.S.C. §103(a) as being obvious over **Heitz** in view of **Cuomo** et al., U.S. Patent No. 6,692,586 (hereinafter "Cuomo").

These rejections are traversed.

Reconsideration of the patentability of claims 1-41 is requested, based on the following remarks.

Patentability of Claims 1-41 over the Heitz et al., Heikman et al. and Cuomo et al. References as Applied in the §102 and §103 Rejections of Claims 1-41

In paragraph 2 at page 2 of the May 9, 2005 Office Action, the examiner has contended that the feature of "having a diameter of at least 25 millimeters, or in the case of square or rectangular wafers, a diagonal dimension of at least 25 mm" relied on by the applicants "are not recited in the rejected claim(s)," citing ***In re Van Geun***, 988 F.2d 1181, 26 USPQ 2d 1057 (Fed. Cir. 1993) for the principle that although claims are interpreted in light of the specification, limitations are not read into the claims.

Applicants concur with the examiner's statement of the law concerning reading limitations of the specification into the claims. This is not in dispute - applicants are in fact not attempting to read in additional limitations, but rather to accord the claim language its expressly defined meaning. As

was stated by United States Court of Appeals for the Federal Circuit in ***Edward H. Phillips v. AWH Corp.***, decided July 12, 2005:

> **"our cases recognize that the specification may reveal a special definition given to a claim term by the patentee...[i]n such cases, the inventor's lexicography governs" (citing *CCS Fitness, Inc. v. Brunswick Corp.*, 288 F3d 1359, 1366 (Fed. Cir. 2002).**

See also ***Multiform Dessicants Inc. v. Medzam Ltd.***, 133 F.3d 1473, 1477, 45 USPQ2d 1429, 1432 (Fed. Cir. 1998) and M.P.E.P. 2111.02 ("[I]t is well-established that a patent applicant may be his own lexicographer, so long as (1) the meaning assigned to a term is not repugnant to its well-known usage, and (2) the special meaning is "sufficiently clear in the specification that any departure from common usage would be so understood by a person of experience in the field of the invention").

The term "large-area" is defined in the instant specification at page 6, paragraph [0022]:

> **"As used herein, the term 'large area' in reference to the GaN material means that such material has a diameter of at least 25 millimeters, or in the case of square or rectangular wafers, a diagonal dimension of at least 25 millimeters. The thickness dimension desirably is at least 300 micrometers, e.g., a thickness in a range of from about 300 micrometers to about 5 centimeters or more. These dimensions are in reference to the wafers as formed from the original crystal growth single wafers or from boules by steps including initial crystal growth to form the boule or ingot article, followed by rounding, sizing, slicing, lapping, polishing, etc. as necessary to produce wafers having surfaces suitable for epitaxial growth thereon."**

Consistent with the applicable governing precedent declared by the CAFC, the term "large-area" as used in applicants' claims has a clear and express meaning.

Accordingly, concerning the rejection of claims 1-10 on §102 grounds, based on Heitz et al., it is to be noted that claim 1, from which claims 2-10 depend, recites:

"Large-area, single-crystal semi-insulating gallium nitride."

in which the term "large-area" means a diameter of at least 25 mm, or in the case of square or rectangular wafers, a diagonal dimension of at least 25 mm, consistent with the definition at page 6, paragraph [0022], above quoted.

As related in the background section of the present application, such "large area" single crystal, insulating gallium nitride has not been achieved by the prior art:

> **"[0005] U.S. Patent 6,273,948 issued to Porowski et al. describes a method of fabricating highly resistive GaN bulk crystals, by crystallization from a solution of atomic nitrogen in a molten mixture of gallium and Group II metal such as beryllium or calcium, under high pressure of 0.5-2.0 GPa and high temperature of 1300-1700° C. Resistivity of 1 x 10^4 to 1 x 10^8 ohm-centimeter (ohm-cm) was achieved. However, the crystal obtained from the process was about 1 cm in size, whereas most commercial electronic applications require a substrate size of at least about 2 inches (> 5 cm) diameter.**
>
> **"[0006] U.S. Patent 5,686,738 (Moustakas), U.S. Patent 6,544,867 (Webb et al.), U.S. Patent 6,261,931 (Keller et al.) and U.S. Patent Application 2002/0096692 A1 (Nakamura et al.), disclose various methods of making semi-insulating GaN films on a foreign substrate. All of these approaches are susceptible to TE mismatch issues, and the resultant Boeing, cracking and small feature fabrication difficulties discussed above, and none of such approaches has yielded a commercially viable, large-area single-crystal semi-insulating gallium nitride material."**

The foregoing references of the above-quoted background text of the application are of interest, since the references identified in such passage are all directed to formation of high resistivity GaN, and all of these references were published after the February 15, 1997 publication date of Heitz et al. (Porowski published on December 10, 1998; Moustakas was issued November 11, 1997; Webb et al. issued on April 8, 2003; Keller et al. issued on July 17, 2001; and Nakamura et al. was published on July 25, 2002), yet **none of the authors of these references was able to make a large area, semi-insulating, single-crystal GaN material**, and these references underscore the fact that large-area, semi-insulating, single-crystal GaN material is not in any way disclosed or suggested by Heitz et al.

Heitz et al. describes GaN layers that are epitaxially grown on (0001) sapphire, but there is **no disclosure or any suggestion whatsoever of the size of the crystal**, merely a mention that the semi-

insulating GaN crystal was 38 μm thick (since, as disclosed in paragraph [0031] of the present application, "[T]he thickness dimension [of applicants' invention] desirably is at least 300 micrometers," **this is hardly suggestive of any material of the present invention**). Additionally, there is no disclosure in Heitz et al. that identifies the GaN material of such reference as being single crystal in character.

Instead, the GaN material of the Heitz et al. reference is ambiguously and indefinitely characterized.

There is no disclosure of bulk resistivity of the GaN material in Heitz et al. Heitz et al. instead is focused on photoluminescence excitation results for iron (3+) luminescence in hexagonal GaN, but even here, Heitz et al. refers to crystal material as having semi-insulating character on the basis of an electron paramagnetic resonance (EPR) signal that is observable in the dark (see Heitz et al. at the page 4382, second column, last paragraph ("[T]he Fe^{3+} EPR signal can be observed in the dark for the crystals 2 and 3 *confirming the semi-insulating character of these two samples*"-emphasis added)).

In the sentence bridging pages 4382 and 4383 of the article, and in the following sentence on page 4383 of the article, Heitz et al. state that in addition to the luminescence observed attributable to the tri-positive cation of iron, luminescence was attributed to Cr^{4+} and Ti^{2+} as well.

In the results section of the article, on page 4383, the authors note that iron "is a general contamination of the crystals" used in their work, and that the luminescence attributed to Fe^{3+} "is representative of all the samples investigated" (including crystal characterized as n-type).

Heitz et al. ignores the basic standard that semi-insulators are characterized by bulk resistivity, and not a luminescent signature. Heitz et al. contains no resistance measurements, no potential gradient determinations, and no rigorous basis for characterizing any GaN material as being semi-insulative in character. Further, the luminescence that is the sole basis of the semi-insulative characterization, is attributed to general contamination of the crystals by iron, chromium and titanium, contaminants that are conceded by the authors to be present in all crystal material considered by them, including n-type crystal material.

Reduce to its essence, the proper inquiry concerning the relevance of Heitz et al. is, if photoluminescence is the indicator specified by Heitz et al. for semi-insulative material, and all

samples investigated by Heitz et al. exhibit such luminescence, including n-type crystal material, <u>then such n-type crystal material must be semi-insulative material according to the criterion of Heitz et al</u>. One skilled in the art, however, knows that n-type crystal material is NOT semi-insulative material, and that n-type material and semi-insulative material reside in different bulk resistivity regimes that demarcate them as n-type or semi-insulative. <u>Heitz et al. therefore is seen to be confusing and contrary to common sense</u>.

It is well settled that an anticipation rejection cannot be predicated on an ambiguous reference. ***In re Turlay***, 304 F.2d 893, 899, 134 USPQ 355, 360 (CCPA 1962).

The character of applicant's claimed material as semi-insulative is fully clear from the definition of such term in paragraph [0024] of the present application:

> [0024] **As used herein, the term "semi-insulating" in reference to the semi-insulating GaN material of the invention means that such material has a resistivity > 100 ohm-centimeters (Ω-cm) at room temperature (~ 25°C). In one embodiment, the GaN material of the invention may have a resistivity > 10^4 Ω-cm at 200°C. In another embodiment, the semi-insulating GaN material may have a resistivity > 10^5 Ω-cm at room temperature. More preferably, the semi-insulating GaN material has a resistivity > 10^5 Ω-cm at 200°C, and most preferably the semi-insulating GaN material has a resistivity > 10^5 Ω-cm at 300°C. Such values of resistivity are determined by four point probing techniques (van der Pauw contact geometry) as a function of temperature. In instances where the GaN material, e.g., as a free-standing substrate article, has microelectronic circuitry fabricated on and/or within such substrate, the GaN material of the invention has a semi-insulating character in the operating temperature regime of such microelectronic circuitry. The term "within" in such context refers to circuitry in which the substrate forms a part of the device, e.g., wherein the substrate is subjected to an implantation process to form implanted device region(s) in the substrate.**

Thus, the contention that Heitz et al. anticipates the subject matter of claims 1-10 is without substantive basis, since (1) <u>Heitz et al. does not teach or suggest large-area gallium nitride</u>, (2) <u>Heitz et al. does not provide any rigorous determination of semi-insulating character</u> since the

photoluminescence characterization results in a mischaracterization of n-type material as semi-insulating, (3) no resistivity information or data is given for any of the materials tested by the authors, and (4) there is no mention anywhere in Heitz et al. of "single crystal" GaN material.

Additional basis of distinction is present in claims 5-8, which recite manganese, cobalt, nickel and copper, respectively. There is no mention of such species in Heitz et al. as dopants for GaN.[1]

It is fundamental law that anticipation under §102 requires the presence in a single reference of each and every element of the claimed invention, arranged as in the claim. ***Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co.***, 221 USPQ 481, 485 (Fed. Cir. 1984); ***Verdegaal Bros. Inc. v. Union Oil Co.***, 814 F2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1986), cert. denied, 484 U.S. 827 (1987). In the present case, Heitz et al. does not disclose each and every element of applicants claimed invention, as recited in applicants' claims 1-10. The stated basis of rejection therefore cannot stand.

It therefore is requested that the examiner reconsider the subject matter of claims 1-10 in light of the foregoing remarks, and correspondingly withdraw the rejection of claims 1-10 based on Heitz et al.

The same distinguishing remarks as set out above are apposite to the rejection of claims 11-13, 15-29 and 31-38 under §103 as being obvious over Heitz et al. It again is pointed out that (1) Heitz et al. does not teach or suggest large-area gallium nitride, (2) Heitz et al. does not provide any rigorous determination of semi-insulating character since the photoluminescence characterization results in a mischaracterization of n-type material as semi-insulating, (3) no resistivity information or data is given for any of the materials tested by the authors, and (4) there is no mention anywhere in Heitz et al. of "single crystal" GaN material.

Accordingly, since claims 11-13, 15-29 and 31-38 require "large-area", "single crystal" and "semi-insulating" gallium nitride, such claims patently distinguish over Heitz et al. and are otherwise in condition for allowance.

[1] It is noted that Heitz, et al. discloses manganese, but in zinc sulfide, not GaN; nickel is discussed in connection with zinc sulfide and cadmium sulfide, but not in connection with GaN; copper is mentioned in connection with II-VI semiconductors, but not in connection with III-V semiconductors such as GaN.

Additional basis of patentable distinction is present in the claims. Heitz et al. teaches a "crystal 3" material that is 38 micrometers thick, but contains no teaching or suggestion of any higher thickness of such "crystal 3" material. Accordingly, there is no derivative basis in Heitz et al. for a thickness in a range of from about 50 micrometers to about 5 cm, as recited in claim 11, or a thickness of from about 300 micrometers to about 5 cm, as recited in claim 13. The same is true for claim 15, which recites a thickness of at least 300 micrometers, and additionally has a diameter of at least 50 mm, for which there is no described or suggestive basis in Heitz et al., and it is also true for claim 16, reciting a thickness in a range of from 300 micrometers to 5 cm.

Further, the resistivity values recited in claim as 17-21 have no derivative basis in Heitz et al., since Heitz et al. fail to disclose any resistivity values, instead focusing on PLE spectra, with the accompanying ambiguity and indefiniteness issues discussed hereinabove. There is correspondingly no basis in Heitz et al. for the impurity concentrations recited in claim 22-25, the defect density levels recited in claims 26-28, or the silicon-oxygen-iron recital of claim 29.

Claims 31-38 likewise have no derivative basis in the Heitz et al. teachings; the gallium nitride recited in (dependent) claims 31-34 is gallium nitride according to claim 1, which Heitz et al. fails to disclose (see preceding discussion).

Additionally, Heitz et al. does not disclose fabrication of any microelectronic device or in the materials described in such reference - although there is mention in the background portion of the article of Group-III nitride-based device structures, there is no teaching or suggestion that the specific GaN material described by Heitz et al. is suitable for specific devices. Instead, the Heitz et al. article is simply a report on photoluminescence excitation investigations of the hexagonal GaN samples, and Heitz et al. contains no instructions or direction for fabricating any microelectronic or optoelectronic device on or in the material that is the subject of the authors' empirical studies. Heitz et al. thus provides no basis for the subject matter of claims 35-38, even if the fact is ignored that such claims are of dependent form under claim 1 and are thereby patentably differentiated over Heitz et al. on such basis alone.

The examiner in reference to Heitz et al. has contended (in paragraph 44, at page 7 of the Office Action) that it would have been obvious to determine optimum thickness, temperature and condition of delivery of layers involved. The relevance of this statement is not understood, since Heitz et al.

provides no "starting basis" from which the applicants' claimed invention can be derived, by routine experimentation or otherwise.

The failure of Heitz et al. in this respect is illustrated, by way of example, in the statement at page 8 of the Office Action concerning claim 29, in which the examiner acknowledges that Heitz fails to disclose a GaN material with background impurities including silicon and oxygen, in which iron dopant has a concentration greater than the total concentration of such silicon and oxygen, but then speculates that:

> **"it would have been obvious that a background impurity of silicon and/or oxygen would render the gallium nitride layer non-insulating and therefore since Heitz teaches a semi-insulating [sic] the silicon and/or oxygen concentration in the background would be obviously low."**

Such rejection of claim 29 therefore is based on a hypothetical importation into GaN material of the silicon and oxygen as background impurities, which are conceded to be absent from Heitz et al., but which somehow, despite the absence of any disclosure in Heitz et al., are put into the material and then somehow, again without basis in the reference, compensated by iron doping.

Such rejection thus is based on a string of speculative hypotheses that are fully outside the scope of any reasonable interpretation of the Heitz et al. reference. There is simply no basis on which one of ordinary skill in the art, reading Heitz et al. for what it fairly discloses, would in any straightforward, logical manner extrapolate the compositional teachings of Heitz et al. to include components which are nowhere mentioned in such reference!

Concerning claim 30, the examiner has rejected such claim over Heitz et al. in view of Heikman et al. "Claim 30 recites a doping concentration of iron in a range of from about 3E16 atoms per cubic centimeter to about 7E17 atoms per cubic centimeter, as determined by SIMS. The examiner has contended that it would have been obvious to one of ordinary skill in the art to incorporate the doping range of Heikman et al. into the Heitz et al. "semiconductor device."

Heikman et al. contains no teaching or suggestion of a large-area, single-crystal GaN. It again is pointed out that the term "large area" requires a transverse dimension (diameter or diagonal, depending on the shape of the wafer; see paragraph [0022] of the present application) of at least 25

mm. The single transverse dimension disclosed in Heikman et al. is the reference dimension of 100 micrometers associated with the dimensional bar in Fig. 2 of the article. Such reference dimension, as applied to the overall height and width of the micrograph, indicates that each of the height and width dimensions of the illustrated section of GaN in Fig. 2 of the Heikman et al. is between 200 and 300 micrometers. The minimum transverse dimension required by applicants' claims (25 mm) is <u>25,000 micrometers, many orders of magnitude above the dimension illustrated in Fig. 2 of Heikman et al.</u>

Further, the surface of the GaN material shown in Fig. 2 of Heikman et al. is <u>highly cracked and discontinuous in character across the full extent of such surface</u>, and such surface in fact is described by Heikman et al. as a "rough surface." This surface of Heikman et al.'s material does not give any indication of being a single crystal material - the extremely rough, cracked, discontinuous character of the material in fact appears more consistent with a polycrystalline or even semi-amorphous material. There is no mention in Heitz et al. of any "single crystal" material.

Still further, the film thickness disclosed in Heikman et al. for the GaN material of such reference is <u>2.6 micrometers, of which only the first 0.3 μm of the film is doped</u>. See the abstract of Heikman et al. See also the Fig. 3 SIMS profile in Heikman et al., which shows a film depth of 1 μm. This is to be contrasted with the disclosure of the applicants' GaN material in paragraph [0022] of the present application, where it is stated that "[T]he thickness dimension [of applicants' GaN material] desirably is at least 300 micrometers." This 300^{+} micrometers thickness is claimed in a number of the pending claims of the present application. Again, such dimensional characteristic of applicants' GaN material is <u>orders of magnitude above the thickness disclosed in Heikman et al</u>.

Moreover, the resistivity values given in Heikman et al. are <u>sheet resistivities</u>, and not bulk resistivities; there is no basis for viewing Heikman et al. as in any way describing or suggesting applicants' claimed GaN material.

The foregoing reflects the fact that the disclosure in Heikman et al. is fundamentally deficient in relation to the disclosure of GaN material in Heitz et al., and <u>there is nothing in their combination that would yield, motivate or extrapolate to applicants' claimed GaN material</u>. The combination of Heitz et al. and Heikman et al. does not yield large-area GaN, and it does not yield a single-crystal GaN.

Concerning claims 14, 39, 40 and 41, the same have been rejected as unpatentable over Heitz et al. in view of Cuomo et al., on the stated basis that "it would have been obvious to one of ordinary skill in the art to incorporate the limitations of Cuomo into the Heitz semiconductor device, because bulk materials can be used as substrates upon which microelectronic and optical devices are fabricated."

The Cuomo reference teaches use of $M^{III}N$ columns for growth of continuous, low defect-density GaN layer that are n-type or p-type (see Cuomo et al., at column 14, lines 22-27), but it does not in any way teach or suggest the formation of semi-insulating gallium nitride, as required by the claims of the present application. Cuomo et al. at column 14, lines 22-27 merely teaches that:

> **"During their respective growth steps, columns 14, CEO layer 20, and/or bulk $M^{III}N$ layer 30 can be doped by conducting conventional doping methods, such as by introducing dopant-containing gases into the reaction chamber under controlled conditions. Multiple or alternating layers of dopants can be added to form electronic devices or components such as, for example, p-n junctions." Cuomo et al., column 14, lines 22-27**

Thus, the only teaching of Cuomo et al. involving doping is a teaching to form PN junctions. PN junctions comprise p-type semiconductors, i.e., semiconductors in which the concentration of holes is much higher than the concentration of electrons, and n-type semiconductors, i.e., semiconductors in which the concentration of electrons is much higher than the concentration of holes. Neither of such types of semiconductor is semi-insulative in character. There is thus an absence of any mention of, or suggestive basis for, semi-insulative material in the disclosure of Cuomo et al.

Accordingly, not only does Cuomo et al. fail to remedy the multiple deficiencies of Heitz et al., Cuomo et al. in fact teaches away from any provision of semi-insulative material, since the teachings of Cuomo et al. are directed to doped material that is either p-type semiconductor or n-type semiconductor, and there is not even a hint of semi-insulative material anywhere in the disclosure of Cuomo et al.

Further, there is no motivation for combining the disparate disclosures of Heitz et al. and Cuomo et al., since Heitz et al. is simply concerned with photoluminescence studies ("[I]n this paper we report a comprehensive PLE investigation"-Heitz et al., at page 4382) and is fundamentally deficient in providing any basis for applicants' claimed invention. Cuomo et al. is concerned with columnar

growth of Group III-nitride, as a platform for growth of bulk materials, and such reference is wholly devoid of any teaching, suggestion or other basis for semi-insulative GaN material.

In consequence, the hypothetical combination of the Heitz et al. and Cuomo et al. references that has been suggested in the Office Action derives solely from an improper hindsight attempt to reconstruct the present invention, and therefore does not provide a proper basis for contending that the subject matter of claims 14 and 39-41 is obvious.

Based on all of the foregoing, the applicants respectfully request the Examiner to reconsider, and upon reconsideration to withdraw, the rejections of claims 1-41.

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If any issues remain outstanding, the Examiner is requested to contact the undersigned attorney at (919) 419-9350 to resolve the same.

Respectfully submitted,

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